EM156305213

01/27/98 jc494 U.S. PTO

09/014252 01/27/98

Please type a plus sign (+) inside this box → [+]

PTO/SB/05 (12/97)
Approved for use through 09/30/00. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	LI30-001	*Total Pages*	35
First Named Inventor or Application Identifier			
Fred A. Brown			
Express Mail Label No.	EM156305213US		

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

1. [X] Fee Transmittal Form *(Submit an original, and a duplicate for fee processing)*
2. [X] Specification [*Total Pages* 25] *(preferred arrangement set forth below)*
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings (*if filed*)
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [X] Drawing(s) *(35 USC 113)* [*Total Sheets* 7]
4. Oath or Declaration [*Total Pages* 3]
   a. [X] Newly executed (original or copy)
   b. [ ] Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 17 completed)* ***[Note Box 5 below]***
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
5. [ ] Incorporation By Reference *(useable if Box 4b is checked)* The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. [ ] Microfiche Computer Program *(Appendix)*
7. Nucleotide and/or Amino Acid Sequence Submission (*if applicable, all necessary)*
   a. [ ] Computer Readable Copy
   b. [ ] Paper Copy (identical to computer copy)
   c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. [X] Assignment Papers (cover sheet & document(s))
9. [ ] 37 CFR 3.73(b) Statement *(when there is an assignee)* [ ] Power of Attorney
10. [ ] English Translation Document *(if applicable)*
11. [X] Information Disclosure Statement (IDS)/PTO-1449 [X] Copies of IDS Citations
12. [ ] Preliminary Amendment
13. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
14. [X] Small Entity Statement(s) [ ] Statement filed in prior application, Status still proper and desired
15. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. [ ] Other: ....

17. **If a CONTINUING APPLICATION,** *check appropriate box and supply the requisite information:*
[ ] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No: ______/______

18. CORRESPONDENCE ADDRESS

[ ] *Customer Number or Bar Code Label* *(Insert Customer No. or Attach bar code label here)* or [X] *Correspondence address below*

NAME	DEEPAK MALHOTRA Wells, St. John, Roberts, Gregory & Matkin P.S.				
ADDRESS	601 West First, Suite 1300				
CITY	Spokane	*STATE*	WA	*ZIP CODE*	99201-3817
COUNTRY	U.S.A.	*TELEPHONE*	(509)624-4276	*FAX*	(509)838-3424

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to spend to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231.

EM156305213

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR LETTERS PATENT

* * * * *

METHODS OF INCREASING POWER HANDLING CAPABILITY OF A POWER LINE

* * * * *

INVENTOR

Fred A. Brown

ATTORNEY'S DOCKET NO. LI30-001

METHODS OF INCREASING POWER HANDLING CAPABILITY OF A POWER LINE

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority from U.S. Provisional application 60/036,021, filed January 31, 1997, titled "Nip and Tuck Power Line Rerating Process", and incorporated herein by reference.

TECHNICAL FIELD

This invention relates to electrical power line re-rating of overhead conductors using one or more of two possible modifications not previously used for this purpose: removing small lengths of conductor, and repositioning conductor support clamps. More particularly, this is a process of determining and making the least cost adjustments to the conductor system of a particular, existing overhead electrical power line so as to allow the conductors in that line to operate at a higher temperature than currently rated without violating safety codes, safety clearances or design standards criteria for conductor sag and tension using these possible modifications, separately or in combination with each other. The intent of these modifications is to selectively increase the tension in the conductor so as to eliminate clearance violations caused by an increase in the sag of the conductor resulting from an increase in the power transfer capability of the electrical power line.

BACKGROUND OF THE INVENTION

Electrical power line owners have a desire and need to transmit more power over existing power lines. As the amount of power being transmitted over a given line (conductor) increases, the temperature of the conductor increases. As the temperature of the conductor increases, the sag of the conductor increases. Existing weather conditions, conductor installation conditions and structural characteristics of the line also affect the amount of sag. Excess sag can put the conductor so close to objects on the earth as to cause flashover, which can damage the line and nearby facilities, cause power outages and endanger animal and plant life.

The current method for line re-rating is to combine sag and tension calculations with any one of a number of commercially available power line analysis computer programs, including longitudinal loading models, to calculate the maximum amperage or conductor temperature that can be used for that line which will not violate safety codes or clearance criteria, nor cause structural or conductor damage. If the desired or required conductor temperature cannot be achieved with the existing design, then the power line owner must resort to one or more of the standard current methods of eliminating the clearance violations. These standard methods include: re-conductoring, raising existing structures, re-tensioning the line between dead end sections, or inserting additional structures. The re-rating process may or may not include field verification of the physical parameters of the power line.

Inherent in any power line rating or re-rating process is the need to determine the behavior of the whole power line and individual conductors operating at higher temperatures. The behavior (sag) of the conductors at high temperatures is generally determined by computer programs, such as Alcoa's SAG10, that calculate the tension and corresponding sag of the conductor based on input of environmental parameters, conductor creep, temperature ranges and other factors. SAG10 is generally available and commonly used within the industry.

The behavior of the power line at high temperatures is determined by a longitudinal loading model. Longitudinal loading models calculate the position of the wire after a change in temperature or loading has occurred. The calculations in these models are based upon the length of wire in a span being fixed at a point in time with known environmental conditions (e.g., ambient temperature) and known geometry and physical characteristics (e.g., longitudinal movement of the conductor supports (insulators), type of conductor support, flexibility of the structures, relative elevation of conductor supports and the spans between structures). As the temperature or loading of the wire changes, the length of wire in that span changes based upon the geometry of the span and the physical properties of the wire, such as coefficient of thermal expansion and creep.

Presently, several procedures exist, used individually or in combination, to predict how much power can be transmitted over an

existing power line, under given environmental conditions, without violating safety codes or design standards.

1. The Institute of Electrical and Electronics Engineers (IEEE), Electrical Power Research Institute (EPRI) and Power Technologies Inc. (PTI) and others, have developed and modified computer programs which calculate the electrical capacity (rating) of a power line based upon thermodynamics and heat transfer physics. These programs use environmental parameters, such as wind speed, wind direction, ambient temperature, solar radiation and line direction to calculate allowable amperage of a line. "Worst case" environmental parameters are established and the power line rating is calculated. These programs, used in combination with a longitudinal load model or power line analysis program establish the maximum amperage (or conductor temperature) at which the line can be operated without violating clearance criteria or damaging the conductor(s). Exceeding this upper bound will very likely cause clearance violations, damage the conductor, or both. The mathematical formulas found in the power line rating programs are generally accepted within the industry.

2. Devices can be installed on the line to monitor the tension in the conductor. Conductor tension is combined with other environmental data, such as the ambient temperature and solar radiation, to predict the rating or electrical capacity of the line.

Patent Nos. 5,517,864 and 5,235,861, both by Tapani O. Seppa (and other patents noted therein), relate to methods of calculating the approximate actual sag of an overhead power transmission line by measuring the amount of tension on the line either by tensiometers or swing angle indicators, as well as measuring ambient temperature, both done at two different times, with no power flow, and then remotely transmitting that information to a computer for performance of calculations. From the data received, a Ruling Span can be calculated from which to determine a maximum safe current that can be transmitted by the existing line without creating excess conductor sag.

3. Israel Electric Company, Haifa, Israel has occasionally used selected algorithms to approximate actual sag under certain combinations of conditions of weather, power transmission and physical design; using basic longitudinal load modeling techniques.

4. Power Line Systems, Inc. is understood to have a computer program (SagSec Software by Peyrot of Power Line Systems, Inc. of Madison, WI) that performs a mathematical analysis of sag and tension, using longitudinal load modeling, including allowance for longitudinal insulator movement.

5. Multiple power line analysis, pole/tower spotting optimization, profile analysis and display computer programs exist, including TLCADD™, PLSCADD, and Optimal. These computer programs

are primarily used in the power line rating process to calculate clearance to the conductors.

6. Current methods to increase the amount of power transmitted over a given line generally require taking the line out of service to make extensive modifications to the conductors or structures, or both. An existing conductor can be replaced with a larger conductor to allow the electrical line to carry an increased load. Alternatively, structures in the existing line can be raised or replaced to allow for the increased sag of the existing conductor when carrying the higher electrical load. Also, new structures can be installed between existing structures to eliminate the low clearance areas caused by increased conductor sag.

The procedures of removing small lengths of conductor and of sliding support clamps have been used in other contexts, but have not been considered for the purpose of re-rating of power lines, as analysis tools and procedures have not been available to perform the complex calculations needed to determine where to make such removals or slide such clamps.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention are described below with reference to the following accompanying drawings.

Figs. 1, 1A are a logical flow chart of the re-rating process.

Fig. 2 is a graph illustrating how Figs. 2A-2C are assembled.

Figs. 2A-2C are a sample of the computer written output showing where along the line a portion of a conductor should be removed, and how much and in which direction to slip the support clamps.

Fig. 3 is a sample of the computer graphic output showing the sag of the conductor under various conditions analyzed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

This disclosure of the invention is submitted in furtherance of the constitutional purposes of the U.S. Patent Laws "to promote the progress of science and useful arts" (Article 1, Section 8).

The purpose of this invention is to analyze, redesign and field modify an existing electrical power line such that it will be able to carry more power without violating clearance criteria, and without

necessarily having to change out the conductor, alter the structures or de-energize the line (where energized line work is permissible and economically advantageous), using the following two procedures, separately or in combination with each other, to eliminate the clearance violation:

1. Removing a length of conductor in the span with the clearance violation, or in adjacent spans;
2. Adjusting the conductor support clamps on structure(s) adjacent to or in the vicinity of the clearance violation.

In particular, this process includes:

1. A determination of whether removal of a portion of the conductor is possible, and if so, how much and where to make such removals;
2. A determination of whether adjusting the conductor support clamps is possible, and if so, where and how much to move the support clamps;
3. Estimations of the costs of making these adjustments and modifications, as well as the costs of using standard procedures now in practice;
4. A recommendation of the best combination of conductor temperature, modification procedure and associated costs; and
5. Performing the actual modifications recommended.

Data is gathered (Fig. 1: Items 1, 2, and 3) from original design documentation and drawings, industry standards and field records. This data includes:

1. (Fig. 1:1) Meteorological conditions to be considered, especially: temperature ranges; wind velocities and directions; and anticipated ice loadings;

2. (Fig. 1:1) Clearance requirements, especially: above ground (Fig. 3:1); from edge of right-of-way; over special areas such as railroads, roadways, and fences;

3. (Fig. 1:1) Cost elements, especially: labor; construction equipment; structures and parts thereof; conductors; insulators; time to do certain types of tasks associated with re-rating lines; opportunity costs if the line must be de-energized to make alterations;

4. (Fig. 1:1) Conductor characteristics, especially: size; tensile strength; creep and stress characteristics over time and at various temperatures, including field measured unbalanced tensions; types and sizes of clamps needed;

5. (Fig. 1:3) Structure characteristics, especially: spacing between (Fig. 3:2); distances from edges of right-of-way; heights; weight bearing capacities (Fig. 3:4); flexibility (Fig. 3:4); insulator type, dimensions, length, swing, strength and field measured actual positions (Fig. 3:4); dead-end locations;

angle locations and actual line angles; attachment heights (Fig. 3:3);

6. Terrain over which the line passes, especially: elevation (Fig. 3:5); width of right-of-way; and special features.

Profile drawings are scanned and digitized using commercially available drafting programs (Fig. 1:4).

All of the data collected is loaded into complete, formatted databases for use in, and as required by, commercially available engineering profile analysis and display programs, such as TLCADD (Fig. 1:5). This data is used for the following calculations.

From the data collected, and using a longitudinal loading model, a preliminary analysis of the power line is performed to evaluate the quality of data collected and identify the problem spans (Fig. 1:5A). Based upon the preliminary evaluation, a detailed visual inspection and detailed survey may be undertaken (Fig. 1:3) to improve the quality of the input data and analysis.

Structural analysis is made of all structures to determine maximum strength and flexibility, using standard, commercially available structural analysis programs, such as STAAD-III, by Research Engineers, Inc.

Conductors are analyzed to determine maximum available strength, sag and creep characteristics, using standard, commercially available conductor sag and tension analysis programs, such as Alcoa's "SAG10".

A best fit, or “Base Case”, computer model of the line is developed to accommodate all the existing data of the line section. This includes plan and profile data, adjusted by field surveys of spans, sags, significant insulator offsets and pole deflections all at the base case temperature.

A “Trial A” is then calculated using a longitudinal loading model analysis (Fig. 1:6). This base case shows what would happen to the conductors if operated at the maximum desired operating temperatures without modification. The multiple-iteration analysis is calculated on a span-by-span basis, considering: span length, weight span, catenaries in each span, insulator swing, insulator weight and stiffness, all to analyze the line under very high temperature (VHT) conditions without the errors introduced by the standard Ruling Span concept.

In this process, the catenary shapes of the wire in each span must be accurately determined for various conductor conditions, such as maximum desired temperature, and wind and ice loadings of the line under normal conditions. This is done through multiple iterations of the calculations in the longitudinal loading model.

From such analysis, clearance violations are identified on an individual span by span basis. This is generally done with a commercially available power line analysis spotting optimization program, such as TLCADD, taking into account the movement of insulator strings and individual structure stiffness.

Also as part of this process (Fig. 1:6), the critical spans (spans with clearance violations) created by higher conductor operating temperatures are noted. The nature and severity of each clearance violation is noted.

a) This invention considers two methods for eliminating the clearance violation in the critical spans, which methods have not previously been used for this purpose. Each of these methods are considered and the resultant line characteristics, on a span-by-span basis, are determined; again, through multiple iterations of the longitudinal loading model. While hand calculations are possible, use of a computer program or other automated procedure will greatly assist the designer with these multiple iteration calculations. It is necessary to analyze each span separately, considering a virtually infinite number of combinations of how much and where to either cut out pieces of the conductor, or to slide the clamps, or some combination of both, over a several span section of the system.

b) Each span must be separately analyzed in order to overcome the errors inherent in the commonly used "Ruling Span" concept. With a change in the length of the wire, there is a corresponding change in the wire tension. To achieve equilibrium at the conductor support points at either end of the span, the insulators and, to a lesser degree, the structures, move to balance the forces in the adjacent spans. The formulae for calculating the change in the length of the wire and the corresponding change in tension are commonly available within the

industry; see, for example, Southwire Company, Overhead Conductor Manual, First Edition, 1994.

c) The movement of the insulators is determined by resolving the forces in a static equilibrium calculation. Since the movement of each insulator is affected by the adjacent spans, mathematically determining the equilibrium points of a multi-span wire system requires multiple calculations in an iterative process. Wire systems larger than two to four spans may require hundreds of calculations in multiple iterations. The availability of commercially available computer programs, such as "SagSec" (by PLS) or "Nip & Tuck" (by ECSI), will speed the calculation process to the point of practicality.

d) Removing a small piece of the conductor increases the tension, which will cause the insulators to move so that equilibrium at the insulator is maintained. Since this insulator movement affects the tension in the adjacent spans, an iterative solution is required to find what the equilibrium point is for each of the affected spans. A similar process occurs when the position of the support clamps is changed. By doing so, the length of wire in two spans are changed, which changes the tension in at least three spans, which will cause the insulators on each end of the spans affected to move to new equilibrium positions. Again, for a multi-span line section, this will require multiple iterations.

In performing these analyses, the designer considers:

1. the initial position of the insulators and conductor;

2. the change in tension in the conductor at each span;

3. the position on the conductor where the support clamps should be reattached;

4. vibration limits on the line and structures (Fig. 1:8);

5. maximum tension capabilities of all components (Fig. 1:8);

6. flexibility of the structures;

7. insulator swing at each structure (Fig. 1:8);

8. resultant load applied to each structure (Fig. 1:8); and

9. the resultant actual catenaries at various temperature and conductor loadings (Fig. 1:7)

The designer will need to use best practice as judgment to determine the true practical feasibility of the recommendations from the first analysis, for removal of pieces of the conductor and movement of clamps at various structure locations, and develop an optimal solution.

A display of the results might look like Figure 2. In this example, the “Trial B” section indicates a need to remove 1.75 feet between 29 and 30 (Fig. 2:1) and a removal of 2.25 feet between structures 22 and 23 (Fig. 2:2). Trial B also recommends a movement of the clamp at structure 30 backwards by .25 feet (Fig. 2:3), and movement of the clamps at structure 29 ahead .25 feet (Fig. 2:4), as well as a backwards movement of the clamp at structure 23 by .25 feet (Fig. 2:5).

"Trial B" is used to verify the sag clearances and insulator deflections at the preferred very high temperature (VHT) operation assuming the corrections introduced, as reflected in the Trial B columns marked "Removal" (Fig 2:6) and "Shift" (Fig. 2:7). As there are potentially an unlimited number of different options regarding the application of the procedures, this "Trial B," may be repeated several times to optimize the cost and find feasible solutions on a difficult section of line. The optimization is usually focused on minimizing the number of field operations, that is minimizing the number of pieces of the conductor to remove and the number of clamp movements. Such things as insulator deflection, longitudinal loading, conductor vibration, uplift, construction access, construct-ability, and energized versus de-energized must also be considered and evaluated by the engineer (Fig. 1:8).

The cost of these procedures, used separately or in conjunction with each other, is calculated and compared to the costs for the standard alternatives (Fig. 1:9).

Using standard engineering procedures, construction estimates are prepared for various standard design modification alternatives (Fig. 1:9). The engineer should include such other standard modification possibilities as:

1. Putting in all new conductor with more power transmission ability; including replacement of components not currently capable of bearing the additional stresses imposed by

new conductor. These components may include poles/towers, crossarms, braces, bolts, insulators and other structural components;

2. Increasing the height of some structures;

3. Increasing the number of structures;

4. Re-sagging: putting the whole line or line segment, from dead end to dead end, in sheaves, pulling it tighter at a fixed location, allowing the line to seek its own sag `level', then re-clamping; and

5. Attempting to do some or all of the field modifications with the power line energized.

In the event the costs of all alternatives are higher than allowable, a recommendation of a lower operating temperature, with calculations made of how much the line could be altered, under the lowest cost alternative, and a determination is made of how much the operating temperature of the conductor could be increased given that level of alteration (Fig. 1:9).

Figure 3 is an example of a graphic output from a commercially available computerized longitudinal loading analysis program showing, in this case, two structures (Fig. 3:7), their station numbers or distance along the line (Fig. 3:6), the sag in the conductor at normal maximum operating temperature and conditions (Fig. 3:8), the expected sag in the line if operated at maximum desired temperature without modification

(Fig. 3:9), and the sag in the line at the higher operating temperature desired and after the determined optimal modification (Fig. 3:10). This is the image that would be used as the final overlay in comparison (Fig. 1:13).

Once a preferred field modification plan is determined, and client approval obtained (Fig. 1:14), then construction drawings and specifications are prepared (Fig. 1:11). A report is prepared for the construction forces (Fig. 1:10). This describes, in order, precisely where and how much conductor to remove and which clamps to move, how far and which direction.

The power line conductor(s) is then physically altered by making the cuts and resetting the clamps as prescribed by the process. The actual field modifications to the conductor are an integral part of the invention as the construction process is only possible with the invention's detailed construction specifications (Fig. 1:12). Standard construction techniques would be used for the actual cutting and splicing of the conductors, and the loosening, sliding and tightening of clamps.

In compliance with the statute, the invention has been described in language more or less specific as to structural and methodical features. It is to be understood, however, that the invention is not limited to the specific features shown and described, since the means herein disclosed comprise preferred forms of putting the invention into effect. The invention is, therefore, claimed in any of its forms or

modifications within the proper scope of the appended claims appropriately interpreted in accordance with the doctrine of equivalents.

CLAIMS:

1. A method of increasing the power handling capability of a power line, the method comprising:

providing a conductor configured to transmit energy intermediate plural locations;

supporting the conductor at a plurality of positions intermediate the locations, the supporting at a plurality of positions defining a plurality of spans of the conductor;

creating a model of the conductor;

identifying a critical span;

altering the modelled conductor responsive to the identifying; and

analyzing the modelled conductor following the altering.

2. The method according to claim 1 further comprising analyzing the modelled conductor at an increased operating condition and the identifying being responsive to the analyzing the modelled conductor at the increased operating condition.

3. The method according to claim 1 further comprising supporting the conductor using a plurality of clamps.

4. The method according to claim 3 wherein the altering the modelled conductor includes at least one of removing a portion of the modelled conductor and adjusting the positioning of one of the clamps within the modelled conductor.

5. The method according to claim 1 further comprising identifying another critical span responsive to the analyzing.

6. The method according to claim 5 further comprising repeating the altering and analyzing following the identifying the another critical span.

7. The method according to claim 1 further comprising optimizing including repeating the altering and the analyzing.

8. The method according to claim 1 wherein the analyzing comprises using a digital computer.

9. A method of increasing power handling capability of a power line, the method comprising:

providing a conductor configured to transmit energy intermediate plural locations;

supporting the conductor using a plurality of clamps; and

altering the conductor including at least one of removing a portion of the conductor and adjusting the positioning of one of the clamps relative to the conductor.

10. The method according to claim 9 further comprising:

creating a model of the conductor;

analyzing the modelled conductor at an increased operating condition; and

identifying a critical span responsive to the analyzing.

11. The method according to claim 10 wherein the altering is responsive to the identifying.

12. The method according to claim 10 further comprising:

altering the modelled conductor following the identifying; and

analyzing the modelled conductor following the altering of the modelled conductor.

13. The method according to claim 12 further comprising optimizing including repeating the altering and the analyzing of the modelled conductor.

14. A method of increasing the power handling capability of a power line, the method comprising:

providing a conductor configured to transmit energy intermediate plural locations;

creating a model of the conductor;

first analyzing the modelled conductor at an increased operating condition;

identifying a critical span responsive to the first analyzing;

altering the modelled conductor responsive to the identifying; and

second analyzing the modelled conductor following the altering.

15. The method according to claim 14 wherein the first analyzing comprises analyzing the modelled conductor at a maximum operating temperature.

16. The method according to claim 14 wherein the first and second analyzings individually comprise using a digital computer.

17. The method according to claim 14 further comprising supporting the conductor using a plurality of clamps.

18. The method according to claim 17 wherein the altering includes at least one of removing a portion of the modelled conductor and adjusting the positioning of one of the clamps within the modelled conductor.

19. The method according to claim 14 further comprising:

identifying another critical span responsive to the second analyzing; and

altering the modelled conductor following the identifying another critical span.

20. The method according to claim 14 further comprising optimizing including repeating the altering and the second analyzing.

ABSTRACT OF THE DISCLOSURE

The present invention includes methods of increasing the power handling capability of a power line. One method of the present invention includes providing a conductor configured to transmit energy intermediate plural locations; supporting the conductor at a plurality of positions intermediate the locations, the supporting at a plurality of positions defining a plurality of spans of the conductor; creating a model of the conductor; identifying a critical span; altering the modelled conductor responsive to the identifying; and analyzing the modelled conductor following the altering.

DECLARATION OF SOLE INVENTOR FOR PATENT APPLICATION

As the below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled: METHODS OF INCREASING POWER HANDLING CAPABILITY OF A POWER LINE.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations §1.56.

PRIOR PROVISIONAL APPLICATIONS:

I hereby claim the benefit under 35 U.S.C. §119(e) of U.S. Provisional Application Serial No. 60/036,021, titled NIP AND TUCK POWER LINE RERATING PROCESS, and filed January 31, 1997.

PRIOR FOREIGN APPLICATIONS:

I hereby state that no applications for foreign patents or inventor's certificates have been filed prior to the date of execution of this declaration.

POWER OF ATTORNEY:

As a named Inventor, I hereby appoint the following attorneys and agent to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Richard J. St. John, Reg. No. 19,363; David P. Roberts, Reg. No. 23,032; Randy A. Gregory, Reg. No. 30,386; Mark S. Matkin, Reg. No. 32,268; James L. Price, Reg. No. 27,376; Deepak Malhotra, Reg. No. 33,560; Mark W. Hendricksen, Reg. No. 32,356; David G. Latwesen, Reg. No. 38,533; George G. Grigel, Reg. No. 31,166; Keith D. Grzelak, Reg. No. 37,144; John S. Reid, Reg. No. 36,369; Lance R. Sadler, Reg. No. 38,605; and James D. Shaurette, Reg. No. 39,833.

Send correspondence to: WELLS, ST. JOHN, ROBERTS, GREGORY & MATKIN P.S., 601 W. First Avenue, Suite 1300, Spokane, WA 99201-3817. Direct telephone calls to: James D. Shaurette (509) 624-4276.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statement may jeopardize the validity of the application or any patent issued therefrom.

* * * * * * * * * *

Full name of sole inventor: **Fred A. Brown**

Inventor's Signature: ~~~~ Fred A Brown ~~~~

Date: January 23, 1998

Residence: **Spokane, Washington**

Citizenship: **U.S.A.**

Post Office Address: **9215 N. Palmer Rd., Spokane, WA 99207**

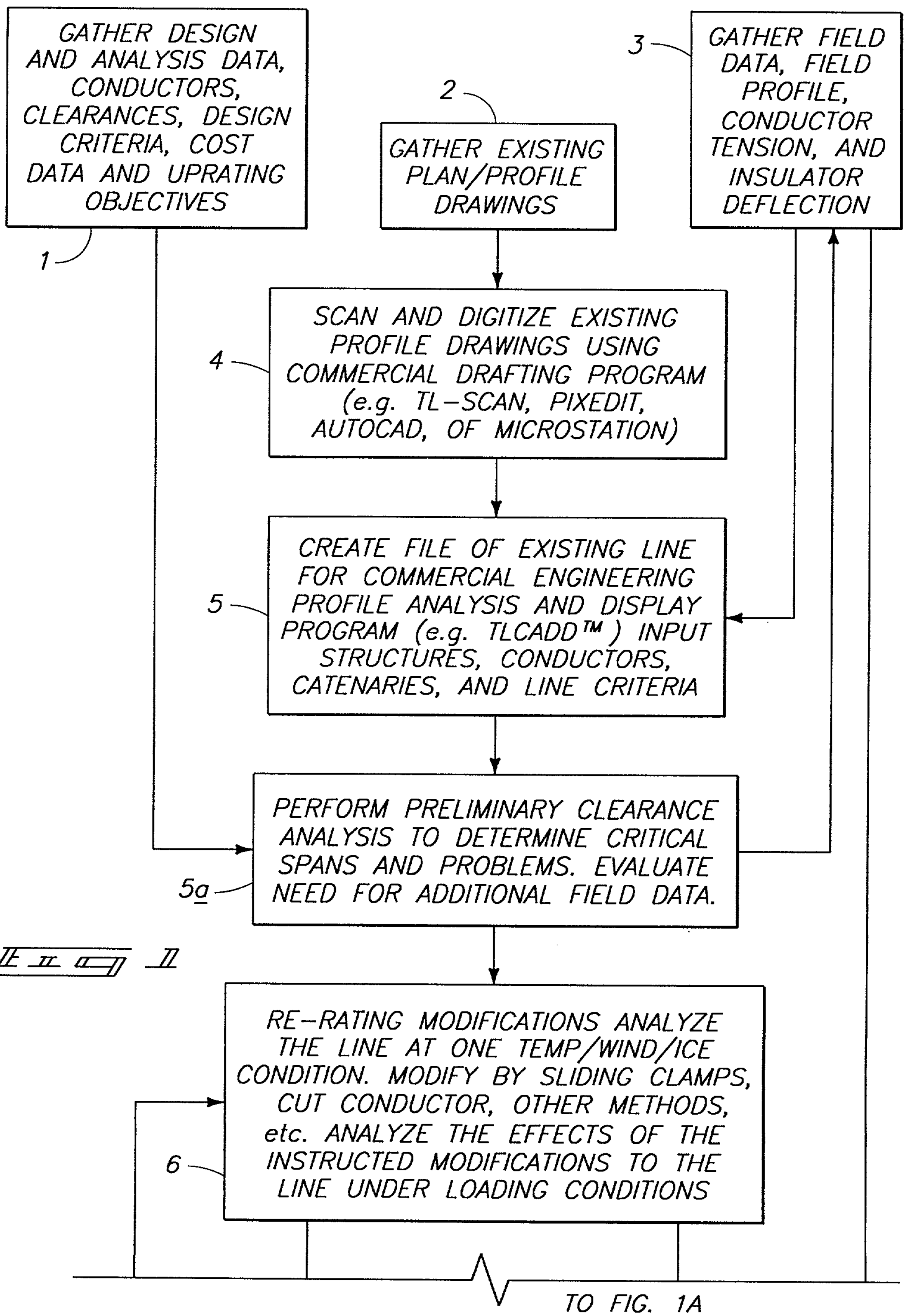
GATHER DESIGN AND ANALYSIS DATA, CONDUCTORS, CLEARANCES, DESIGN CRITERIA, COST DATA AND UPRATING OBJECTIVES
1
2
GATHER EXISTING PLAN/PROFILE DRAWINGS
3
GATHER FIELD DATA, FIELD PROFILE, CONDUCTOR TENSION, AND INSULATOR DEFLECTION
4
SCAN AND DIGITIZE EXISTING PROFILE DRAWINGS USING COMMERCIAL DRAFTING PROGRAM (e.g. TL-SCAN, PIXEDIT, AUTOCAD, OF MICROSTATION)
5
CREATE FILE OF EXISTING LINE FOR COMMERCIAL ENGINEERING PROFILE ANALYSIS AND DISPLAY PROGRAM (e.g. TLCADD™) INPUT STRUCTURES, CONDUCTORS, CATENARIES, AND LINE CRITERIA
5a
PERFORM PRELIMINARY CLEARANCE ANALYSIS TO DETERMINE CRITICAL SPANS AND PROBLEMS. EVALUATE NEED FOR ADDITIONAL FIELD DATA.
6
RE-RATING MODIFICATIONS ANALYZE THE LINE AT ONE TEMP/WIND/ICE CONDITION. MODIFY BY SLIDING CLAMPS, CUT CONDUCTOR, OTHER METHODS, etc. ANALYZE THE EFFECTS OF THE INSTRUCTED MODIFICATIONS TO THE LINE UNDER LOADING CONDITIONS
TO FIG. 1A

Fig. 1

LI30-001

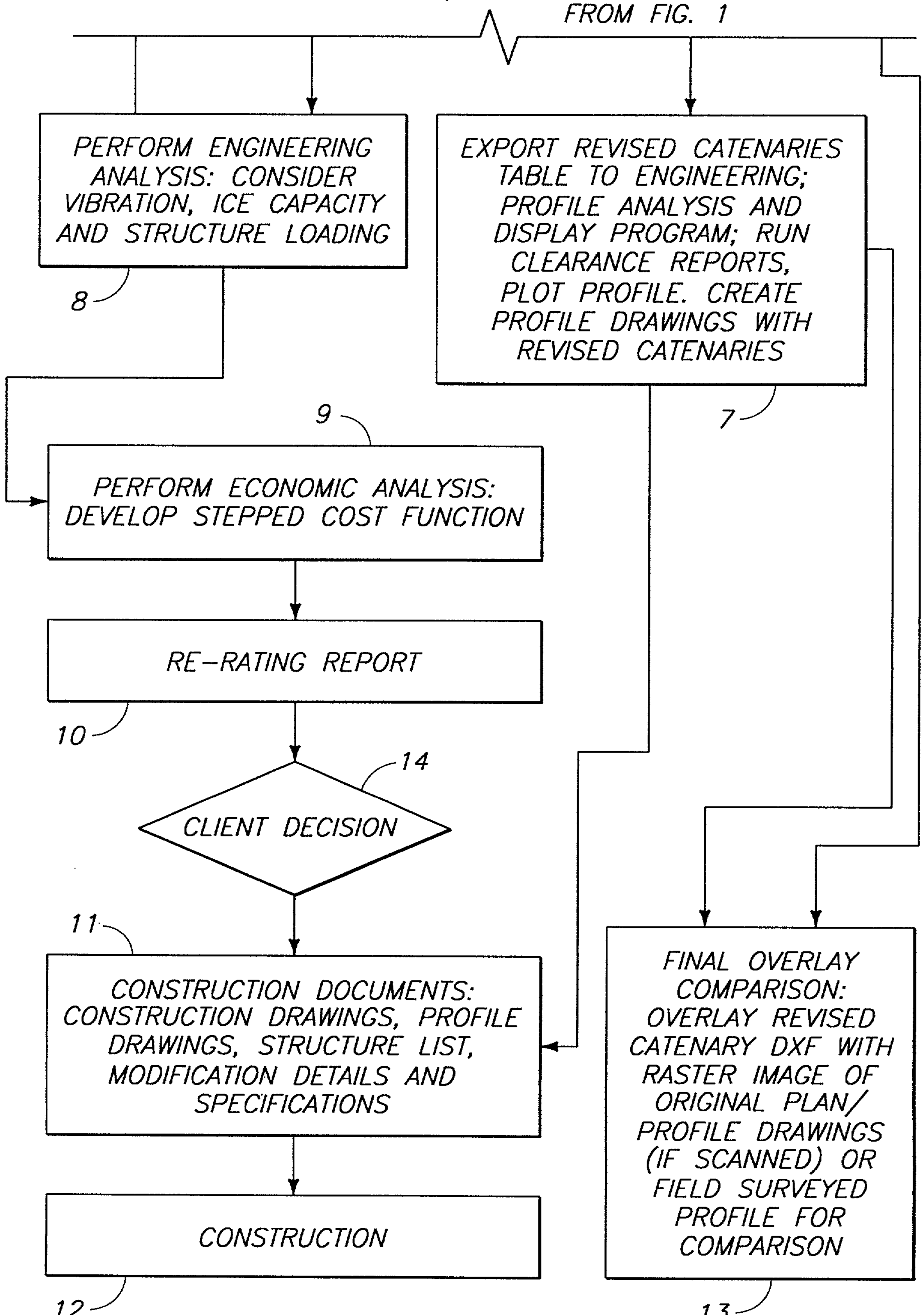

Fig. 1A

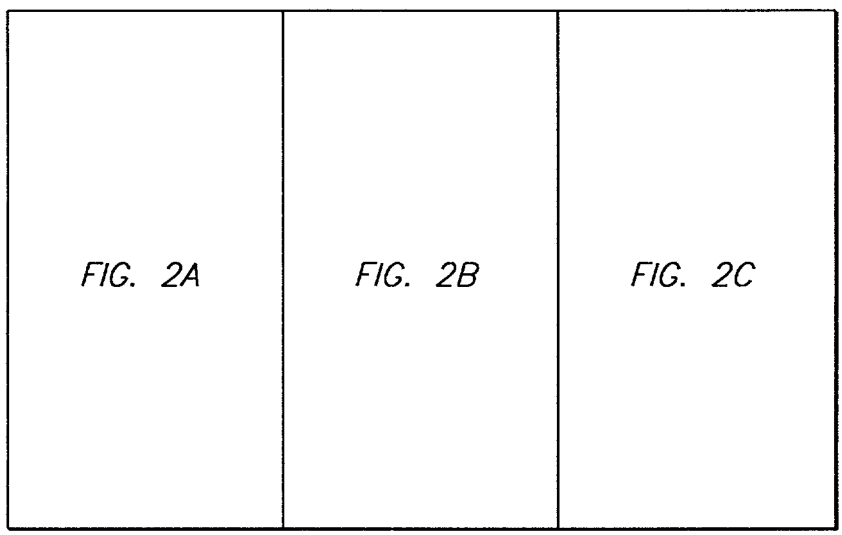

Fig 2

STATION	STR	LINE ANGLE	SPAN	DEFLECT	SAG	C
BASE CASE 60 DEG. F TENSION = 3400LB.						
3707	36	82.1		0.000		
			993.0		19.818	6219
4700	35	0		0.000		
			775.0		12.071	6220
5475	34	0		0.000		
			925.0		17.196	6220
6400	33	0		0.000		
			825.0		13.679	6220
7225	32	0		0.000		
			875.0		15.387	6220
8100	31	0		0.000		
			875.0		15.387	6220
8975	30	0		0.000		
			925.0		17.196	6220
9900	29	0		0.000		
			925.0		17.196	6220
10825	28	0		0.000		
			919.7		17.001	6219
11744.7	27	−11.48		0.000		
			830.3		13.855	6220
12575	26	0		0.000		
			825.0		13.679	6219
13400	25	0		0.000		
			675.0		9.157	6220
14075	24	0		0.000		
			900.0		16.279	6220
14975	23	0		0.000		
			975.0		19.105	6220
15950	22	0		0.000		
			750.0		11.305	6220
16700	21	0		0.000		
			1000.0		20.098	6220

Fig 2A

	TRIAL A REMOVAL	TRIAL A SHIFT	TRIAL A DEFLECT	TRIAL A SAG	TRIAL A C
TRIAL A 212 DEG. F					
			0.000		
				31.434	3919
			−0.245		
				19.445	3863
			0.003		
				27.675	3864
			−0.099		
				22.153	3842
			0.033		
				24.873	3848
			0.052		
				24.814	3857
			0.081		
				27.607	3873
			−0.010		
				27.634	3870
			−0.104		
				27.499	3844
			−0.213		
				22.676	3801
			−0.130		
				22.554	3773
			−0.062		
				15.154	3762
			0.267		
				26.555	3812
			0.177		
				30.833	3852
			−0.104		
				18.366	3831
			0.163		
				32.300	3867

FIG 2B

	6 TRIAL B REMOVAL	7 TRIAL B SHIFT	TRIAL B DEFLECT	TRIAL B SAG	TRIAL B C
TRIAL B 212 DEG. F W/N&T					
		0	0.000		
	0			29.940	4115
		−0.25	−0.229		
	0			18.512	4062
		0	0.411		
	1			25.781	4141
		0	−0.374		
	0			21.008	4058
		0.5	0.442		
	0			23.066	4147
		0	0.253		
	0	3		22.797	4199
	1	−0.25	0.359		
	1.75	4		24.968	4275
		0.25	−0.544		
	0			25.817	4147
		0.5	−0.079		
	0			25.598	4128
		0	−0.368		
	0			21.279	4053
		0	−0.064		
	0			21.078	4039
		0	0.239		
	0			13.972	4082
		0	0.728		
	0	5		24.013	4217
	2	−0.25	0.810		
	2.25			26.920	4400
		0	−0.800		
	0			16.638	4232
		0	−0.283		
	0			29.970	4171

Fig 2C

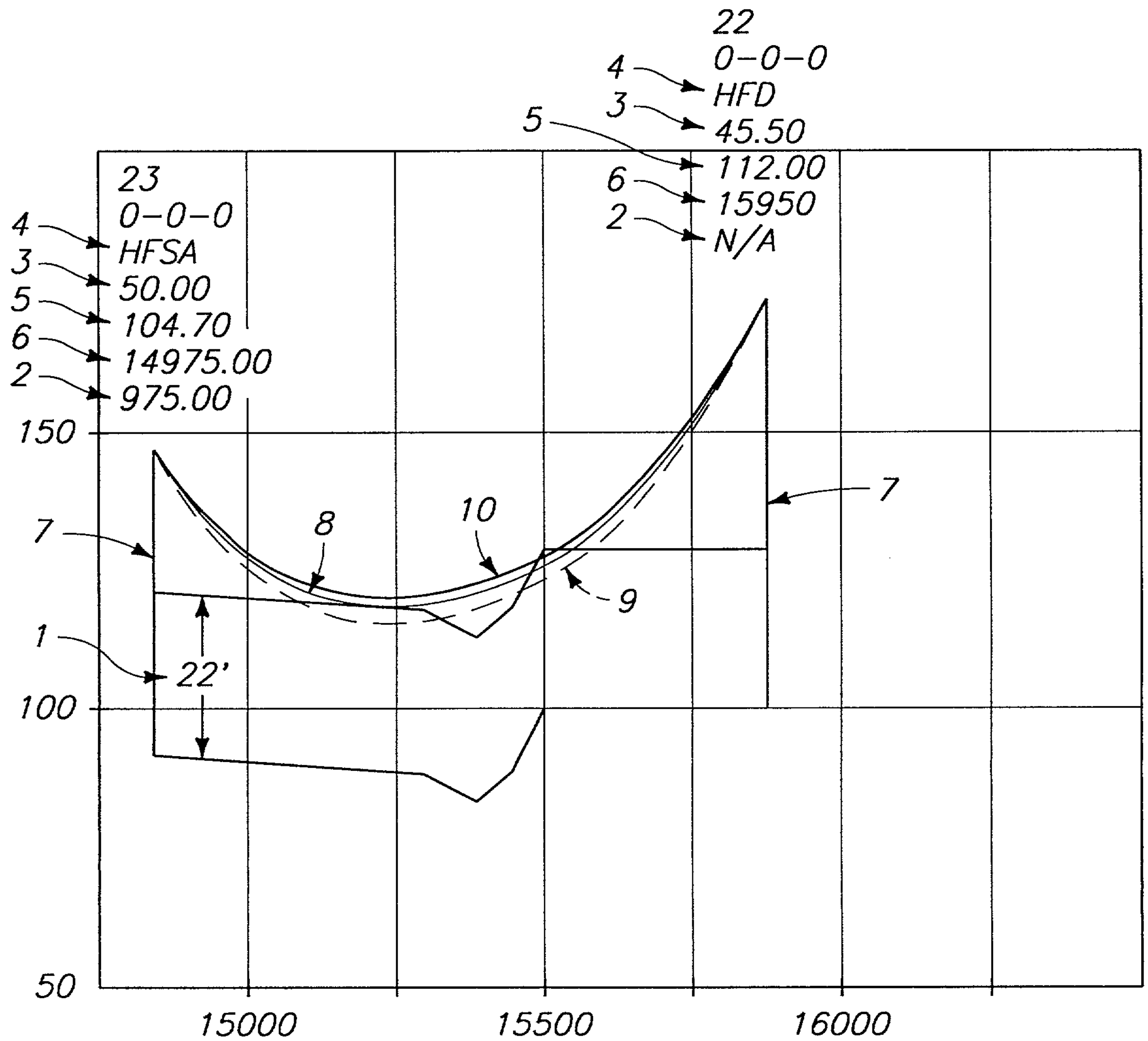
22
0-0-0
4
HFD
3
45.50
5
112.00
6
15950
2
N/A
23
0-0-0
4
HFSA
3
50.00
5
104.70
6
14975.00
2
975.00
150
7
8
10
9
1
22'
100
50
15000
15500
16000

FIG. 3

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor . . . . Fred A. Brown
Attorney's Docket No. LI30-001
Title: Methods of Increasing Power Handling Capability of a Power Line

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) and 1.27(c)) - SMALL BUSINESS CONCERN

I hereby declare that I am

[ ] the owner of the small business concern identified below:
[X] an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: ECSI Corporation
ADDRESS OF CONCERN: 2314 N. Cherry St., Spokane, WA 99216

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled Methods of Increasing Power Handling Capability of a Power Line.

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e). *Note: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

NAME:
ADDRESS:
[ ] Individual [ ] Small Business Concern [ ] Nonprofit Organization

NAME:
ADDRESS:
[ ] Individual [ ] Small Business Concern [ ] Nonprofit Organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Name of Person Signing Ron J. Carrington
Title of Person Other Than Owner Engineering Manager
Address of Person Signing 2314 N. Cherry Street, Spokane WA 99216

Signature Ron J Carrington Date 1/27/98